AQA A Level

Product Design

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SERIES B

Sample paper TWO

Mark Scheme

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A Level Design & Technology (Product Design)

Series B – Paper 2 mark scheme

This sample paper and mark scheme has been carefully compiled and checked to ensure parity with the AQA guidelines available. It is the normal process for the mark schemes of live papers to go through a standardisation process where students' responses are analysed and any answers not covered in the mark scheme are discussed and legislated for. As this is a sample paper only, this process has not been undertaken. Whilst this paper and mark scheme have been technically proofread, there may be additional responses that are worthy of marks. Teachers discretion should be applied in these circumstances.

Instructions for level of response marking

Descriptors are provided for different levels of response along with appropriate marks for each level. Read through a students' answer, annotating to show the qualities that have been achieved, before applying the level based mark scheme.

Determining a level

Start with the lowest level of response in the mark scheme and assess if the different qualities indicated have been met. If they have, move to the next level and check to see if these have been met. Continue the process until you can match the level with the answer. With repetition it becomes easier and quicker to work up through the levels of the mark scheme.

The principle of 'best fit' should be adopted and if small elements of a level are missing but the majority has been covered, then this is the appropriate level to award.

Determining a mark within a level

Having decided on the level, the mark within the level must be determined. Use the descriptors to help with this along with the indicative content. Where there is any doubt, it is advisable to read back through the answers again and reapply it to the indicative content. Students do not need to cover all of the indicative content to reach the top marks. Additionally the indicative content is not designed to be exhaustive and alternative appropriate answers may well be taken into consideration.

Student answers that do not contain any relevent content must be awarded zero marks.

SECTION A

1. **Award marks as shown.** **[8 marks]**

7-8 marks	A thorough and detailed comparison of both toothbrushes and how they use materials and components to make then suitable for their intended use. Expect reference to specific named materials, how they are processed and what makes them suitable for the given application.
5-6 marks	Good understanding of how both toothbrushes use materials and components to make them suitable for intended use. Attempt to identify specific materials and describe how they are processed to make them suitable for use.
3-4 marks	Basic understanding of materials and components are used in both toothbrushes. Little direct comparison between products. Lacking specific and appropriate material and component detail in places.
1-2 marks	Limited number of points considering suitability of some identified materials and components. No direct comparison between toothbrushes.
0 marks	Nothing worthy of credit.

Indicative content: accept alternative responses worthy of credit

Electronic toothbrush:

- Polypropylene and polyethene (other polymers may be used) (same for manual brush)
- Nylon for bristles and thermoplastic elastomer (TPE) for over moulding a soft touch hand grip (same for manual brush)
- ABS plastic used for parts of the electronic case and tooth brush holder
- Thermoforming polymers ideally suited to encapsulation of nylon bristles, so they are secure (same for manual brush)
- TPE over moulding reduces vibrations and increased friction to reduce the chances of user losing grip with wet hand
- Nylon is particularly hardwearing so ideal for brush bristles (same for manual brush)
- Use of polymer as a waterproof material ideal due to close proximity to water when in use (same for manual brush)
- Use of thermoplastics that are easy to clean, can be formed easily into ergonomic shapes, high resistance to chemicals i.e. toothpaste (same for manual brush)
- Motor, rechargeable battery, piezo crystal to create ultrasonic motions
- Induction charging device means electronic components with the toothbrush do no come into direct contact with water
- Casing of electronics can be hermetically sealed to prevent water ingress
- Detachable heads mean one toothbrush body can be shared by a whole family, saving on materials and cost
- Interchangeable brush heads allow for ease of periodic replacement without excessive consumption of materials
- Use of polymers that can be recycled, however, parts are not easy to disassemble and over moulding makes recycling difficult/uneconomical (same for manual brush)

- Electronics require careful separation and cannot be recycled in normal domestic plastic recycling
- Use of oscillating brush action or ultrasonic cleaning means more effective cleaning and better dental hygiene for end user
- Use of electronics allow for sensors to stop mechanical action if too much pressure is applied and protect gums
- Auto shut off/timer to alert user to when the recommended brushing time is over
- Indicator light alerting end user when a recharge is needed

Manual toothbrush:

- Polypropylene or polyethene for handle
- Nylon for bristles and TPE for over moulding a soft touch hand grip
- Over moulding increases friction and is formed into ridges for comfort and a secure grip
- A relatively low-cost option for the consumer
- No moving parts or electronic components that could fail
- Does not require mains power source e.g. ideal for camping or on a journey
- Will not accidentally be switched on e.g. when packed in a bag/suitcase
- Potentially easier to recycle e.g. no electronics and all thermoplastic polymers can be recycled, however, due to bristles and over moulding most domestic recycling won't be able to deal with the separation required
- Not as effective in cleaning your teeth as an electronic toothbrush
- Over moulding can be used for other features e.g. a tongue cleaner to be added on the back of the toothbrush head (same for electric brush)

2. **Award marks as shown. Use the grid below to mark both parts of the question. Award a maximum of 3 marks for each part of the question.**

[2 x 3 marks]

3 marks	One or more specific points explained in detail. Clarity on how each development has led to improvements in the design of electronic products.
2 marks	One statement with a relevant explanation as to how the major development has led to an improvement in the design of electronic products.
1 marks	A simple statement without explanation referring to a single improvement in the design of electronic products.
0 marks	Nothing worthy of credit.

Indicative content: accept alternative responses worthy of credit

Micro electronics

- Miniaturisation of electronic components and circuit board, products have become smaller and so devices of the same size or smaller can perform many different functions
- A smaller board can now process more information in a space/size unimaginable a few years ago

- Use of surface mount technology and multi-layered PCBs has led to smaller circuits as Through-hole technology for soldering is no longer required
- Surface mount technology and quick release fasteners made from shape memory alloy, mean that circuit boards are much easier to separate in to their constituent parts at time of disposal
- Sensing devices have become more capable and accurate allowing information to be available for health, communication etc., e.g. accelerometers and GPS
- Devices that were normally hardware can now be created in software and operated in one device
- Touch screen technology has allowed users to become more interactive with devices and have a more realistic experience
- Prolonged battery life and shorter charging cycles along with Wi-Fi and mobile network access have allowed wire free working. Many devices are now being made with this capability in mind e.g. portable and connected

Advancements in CAD/CAM

- Virtual modelling; built in non-destructive testing of circuits before committing time and resources to make a product
- CAD used for PCB design and efficient use/layout of components
- CAD is used to design how PICs Programmable Interface Controllers perform in devices – also makes upgrading easier e.g. firmware/software updates
- CAD is used to program PIC chip can perform more functions than traditional single process block, delaying obsolescence
- CAD/CAM allows for much improved QA and QC procedures, reducing wasted time, materials and defective products during manufacture
- Reduced human error; automated machines can manufacture to very small tolerances; this has allowed electronic products to increase in sophistication and complexity to meet user demands
- 'Pick and place' machines used in the construction of PCBs; increased accuracy and efficiency which is impossible for humans therefore designs can be smaller/compact
- Use of CAD to work with CAM and modern manufacturing techniques to 3D print components and parts during prototype development reducing production times
- Multi-axis CNC milling machines enabling complex designs to be created
- Increased computing/processing power to enable faster and more complex CAD and CAM

3. **Award marks as shown.** **[12 marks]**

10-12 marks	A thorough and detailed discussion of several relevant factors. Excellent understanding of the messages that can be conveyed to the customer through packaging. Clear reference to a variety of specific features found on packaging to support response. Detailed justification.
7-9 marks	Balanced discussion, showing a good understanding of the messages that can be conveyed to the customer through packaging. Reference to specific features found on packaging to support response. Most points are justified.

4-6 marks	Basic points made considering how messages can be conveyed to the customer through packaging. Response is descriptive rather than evaluative. Some justification.
1-3 marks	Some understanding of messages conveyed through packaging. Points have little/no justification.
0 marks	Nothing worthy of credit.

Indicative content: accept alternative responses worthy of credit

- Product is often pictured or visible through a transparent window to give consumers an idea of product shape, form, aesthetics etc.
- Brand promotion; logo of the brand is clearly visible, often several times on a package; aesthetics e.g. colour scheme, style, form of packaging used to reinforce the 'look and feel' of the brand
- Special finishes such as soft-touch, foil blocking, spot lamination can be used to convey quality and add value to the packaging/brand
- BSI Kitemark™; evidence that the product has been independently and rigorously tested against quality and safety standards by the BSI (British Standards Institution) in order to meet a recognised industry standard or need. The manufacturer wants to re-assure consumers that the product is high quality, safe and reliable product.
- CE mark; shows product is constructed to European standards, shows a minimum standard of quality but not an indication of independent testing
- Mobius Loop used to indicate that parts of the product or packaging are suitable for recycling
- Technical features/product specification e.g. dB rating so the consumer knows how much noise the product will make in use, power rating (220-240 volts/1000 watts)
- Basic description of function and directions for use
- Handling details e.g. fragile, this way up, open from this end
- Highlight packaging opening/closure for ease of use
- Manufacturing details e.g. country of origin, customer care details, website required by law, allows consumers to contact manufacturer
- Patent/registered design to clearly indicate and tell the customer that the product is the genuine article
- Basic warranty and repair/replace details on packaging
- Model /stock number to help the customer to identify the product e.g. for guarantee/warranty etc.
- Disposal instructions, such as a wheelie bin symbol (WEEE), to inform customer that the product should not be disposed of in general waste
- Storage instructions, indicated the conditions in which the product should be stored e.g. within a certain temperature range
- Price and/or promotions, RRP displayed, promotions may relate to accessories not included in the box but available for purchase e.g. a smaller portable hand vacuum cleaner
- Plain brown untreated / Kraft packaging with minimal printing to show 'eco' or 'green' credentials/association
- Bar codes used to track product, manage stocks, carry information about product e.g. price

4. **For each symbol, award 1 mark for specific situation where the symbol would be found and a further 1 mark for a simple explanation of its meaning and another 1 mark for a more detailed explanation.** **[9 marks]**

	**Found on:** Products and services where safety and quality is important - from manhole covers to smoke alarms; security locks to fire extinguishers; and windows and doors to riding helmets. **Accept any other reasonable response.** **Meaning:** Known as the BSI Kitemark™. The mark confirms a product has been independently and rigorously tested by BSI (British Standards Institution) in order to meet a recognized industry standard or need. Indicates quality, reliability and safety in products and services.
	**Found on:** Products made from wood, packaging for timbers and timber products, branded on to timbers, also found on paper and board product. **Accept any other reasonable response.** **Meaning:** The Forest Stewardship Council symbol; means wood is grown sustainably and sourced from forest adhering to FSC standards. FSC forests are managed with environmental, social and economic issues in mind e.g. new trees are planted when mature trees are cut down. Products made are manufactured in line with FSC standards and with approval of other organisations like Greenpeace.
	**Found on:** Products and packaging that can be recycled. **Accept any other reasonable response.** **Meaning:** Known as the Mobius Loop. An internationally recognised recycling symbol. May identify a specific type of polymer e.g. numbers inside the loop indicates the polymer used; allowing for easy classification, identification of food safe polymers etc. Can have a percentage inside the arrows indicating the percentage of recycled material used in the product. Used on other materials such as paper and board products

SECTION B

5. **Award 1 mark for each correct response.**
Each response may only be used once. **[3 marks]**

Application	CAM equipment
Cutting vinyl lettering for a van	Plotter cutter
Machining an MDF wardrobe door	CNC router
Cutting and engraving acrylic sheet for a shop sign	Laser cutter

6. **Award 1 mark for a relevant point.**

Award 2 marks for a relevant point with further explanation or clarification.

Any combination of the above up to a maximum of 3 marks. Award a maximum of 2 marks if relevant points are given but without explanation.

Award 1 mark for a correct example of where/when non-destructive testing would be used. **[4 marks]**

Indicative content: accept alternative responses worthy of credit

Non-destructive testing:

- Makes use of X-rays
- Makes use of ultrasound
- Other methods include magnetic particle testing, liquid penetration testing
- Used to test and analyse a material, sample or component without damaging it
- The material or component/part can still be used after the test is completed

When and when non-destructive testing would be used:

- Used to test and inspect a material or component beneath its surface i.e. subsurface and check for flaws like micro cracks, hollows/voids
- Can test for creep and fatigue, weakness in joints etc.
- It can be used to determine the size and position of flaws and defects with precision
- Inspect and test large parts and component during their working life without causing damage e.g. airplane wings where it would be unrealistic to dismantle a wing assembly or test it to destruction
- Used to inspect particular areas of weakness e.g. joints/welds
- Can be carried out during manufacture and installation as well as once product is in service e.g. bridges an architecture
- Can test for insect and fungal attack occurring below the surface e.g. timbers

7. **Award 1 mark for a simple definition and a further 1 mark for each simple explanation or 2 marks for a detailed explanation.**

[3 marks]

Indicative content:

- Definition - A management system for long-term success, where every employee is committed to maintaining the highest standards of work in whatever role/job they have in an organisation leading to customer satisfaction
- Opinions of employees are sought and valued by the leadership team
- Embedded in effective quality assurance (QA) before, during and after manufacture
- Focus on continuous improvement
- Identifies and implements systems, strategies and structures to reduce waste/inefficiencies to make products 'right first time'
- TQM organisations have highly effective internal communications and procedures in place to keep everyone in the organisation informed
- Reference to training of all staff/employees to maintain quality standards

8. **Award marks as shown.** **[6 marks]**

5-6 marks	The response demonstrates excellent understanding. Full and comprehensive explanation of the impact of global manufacture on product miles and how this affects responsible design.
3-4 marks	The response demonstrates some understanding and gives detail in places of the impact of global manufacture on product miles and how this affects responsible design. Some areas may not be covered in detail.
1-2 marks	The response provides a basic explanation of the impact of global manufacture on product miles and how this affects responsible design. One or more areas may not be covered.
0 marks	Nothing worthy of credit.

Indicative content:

- Global manufacturing involves an international network of companies/manufacturers who contribute to the creation of a product e.g. different companies used for raw materials processing, manufacture of components, sub-assemblies, assemblies, packaging etc.
- Global supply chain can take advantages of expertise and labour provided by specialists and/or at a lower cost; this can reduce costs for the consumer
- Product miles refers to the distances travelled to bring all necessary materials/parts for a product together – complex products will have supply chains from various places across the globe, adding to product miles
- Each product mile has a negative impact on fossil fuel emissions and global warming
- Responsible design seeks to reduce product miles by sourcing materials and parts locally
- Global manufacturing can have a positive effect on communities e.g. stimulates local economy, provides jobs etc.

9. **Award marks as shown.** **[8 marks]**

7-8 marks	A thorough and detailed evaluation of both methodologies. Detailed, informed and fully justified discussion of the advantages and disadvantages.
5-6 marks	A good evaluation of both methodologies. A clear discussion of some of the advantages and disadvantages with most points justified.
3-4 marks	Some evaluation of at least one of the methodologies. Some advantages and at least one disadvantage given. Points may lack justification. Response may fail to differentiate clearly between the two methodologies.
1-2 marks	Limited points made in the evaluation. Basic reference to at least one of the methodologies. Little/no justification.
0 marks	Nothing worthy of credit.

Indicative content:

Collaborative design:

- An ideation system where individuals work together in teams; some people may prefer to work independently while others thrive in teams
- Success of methodology depends on relationships within the team which may be good or bad depending on the individuals
- Can instil a sense of competition; this may be motivating for some and not others
- Allows companies to work on a complex problem where skills and expertise can be sourced from several different personnel e.g. vehicle design
- The team can work to capitalise on the strengths of individuals, delegations of different tasks to different people can save time
- Can help create a better/more effective product and bring it to market faster e.g. an organisation may seek the input of a child psychologist to understand how children learn before commissioning a new educational toy
- Collaborative working stimulates an effective ‘problem solving’ environment

Iterative design:

- An ideation process that follows a cycle of designing, prototyping, testing and modification
- An iteration is a ‘version’ or prototype before a final production ready design is arrived at
- Can be restrictive as sometimes the best ideas are the first ideas generated
- Can be difficult to stick to a deadline as the process of iteration can go on and on
- Modifications and improvements to a design are made based on tests/focus groups responses/feedback of some kind to give a more robust outcome
- Design process often characterised by incremental steps in the improvement/development of products; process allows for / encourages creative leaps as well as smaller modifications
- Focus on getting ideas into physical or virtual prototype form quickly so problems can be identified and resolved faster; however, prototyping can be time consuming

- Cyclical process is repeated until an acceptable outcome is produced
- Iteration can take place at different stages of design e.g. the product itself, its packaging or technical support

10. **Award marks as stated**

(a) Mathematical calculations (allow error carried forward to second mark) **[2 marks]**

1 mark	**Calculate area of rectangle:** 450 × 400 = 180,000mm^2 or 0.18m^2
1 mark	**Calculate area wasted:** 0.18 × 0.3 = 0.05m^2 (0.054m^2 rounded down)

(b) Mathematical calculations **[2 marks]**

1 mark	1189 / 450 = 2.64 or 450 + 450 = 900 So, two whole sheets along one axis 841 / 400 = 2.1 or 400 + 400 = 800 So, two whole sheets along other axis Accept any suitable diagram as workings.
1 mark	2 × 2 = 4 rectangular shapes / nets from each A0 sheet

(c) Mathematical calculations **[4 marks]**

3 marks	**Workings:** Material wasted: 289 × 841 = 243,049 [0.243] **with** 41 × 900 = 36,900 or [0.0369] [2 marks] **or** 289 × 800 = 231,200 [0.23] **with** 41 × 1189 = 48,749 [0.049] [2 marks] **or** sum total 279,949^{2}mm [0.28m^2] seen [2 marks]

	Calculate waste from four nets: 0.054m^2 (or answer from part (a)) × 4 = 0.216m^2 [or 216,000mm^2] [1 mark] or Material used: 400 × 2 × 450 × 2 = 800 × 900 = 720,000mm^2 or 0.72m^2 [2 marks] 0.72m^2 × 0.7 = 0.504m^2 [1 mark]
1 mark	**Calculate total waste from four packaging nets:** 279,949 + 216,000 = 495,949 to 3 s.f. = 496,000mm^2 or 0.496m^2 or **Calculate A0 area:** 1189 × 841 = 1.189 × 0.841 = 0.999949mm^2 0.999949 – 0.504 = 0.495949 to 3 s.f. = 496,000mm^2 or 0.496m^2

(d) Mathematical calculations **[1 mark]**

1 mark	Answer from 10 (c) × 100 / 0.999949 = 49.597% Accept answers within 1% due to earlier rounding

11. **Award marks as shown for each part of the question.** **[2 x 6 marks]**

5-6 marks	Excellent discussion how socio-economic influences have shaped product design and manufacture. At least two specific examples used to develop discussion and confirm understanding.
3-4 marks	Good understanding of how socio-economic influences have shaped product design and manufacture. Consideration of a least one specific example product.
1-2 marks	Basic discussion showing an awareness of socio-economic influences with some explanation or example.
1 mark	Very limited discussion of a single socio- economic influence. No use of example products to develop discussion.
0 marks	Nothing worthy of credit.

Indicative content: accept alternative responses worthy of credit

(a) World War I

- Development of mass production/the production line to readily satisfy demand for munitions
- Mass production led to falling price of goods, they became more affordable
- Mass production led to rapid improvements in quality and consistency as well as efficiency, products worked more reliably
- Workers had the opportunity to elevate themselves out of the working class, more disposable income for more people
- Henry Ford introduced the production line to rapidly increase production capacity of his Ford Model-T; this was in response to the growing population, wealth and desire for mobility across the continent of North America
- People who lived in urban areas found their lifestyles improved and more employment opportunities
- A reduction in low skilled jobs impacting on the income and life chances in some working-class populations
- Some migration from rural areas to towns and cities to seek a better life – move away from agriculture
- Mass production and production lines were viewed as dehumanising and contrary to many ideals of how modern society should be
- Advances in material technology requiring new methods of manufacture i.e. tubular steel

(b) World War II

- Utility products came about due to shortages in materials and rationing e.g. clothing, furniture, raw materials
- Emergency products developed to satisfy acute demand in a hostile socio-economic climate with rationing and shortages
- Innovative designs borne from need as well as lack of materials
- Designer Gordon Russell led a committee charged with ensuring scarce material resources were used as efficiently as possible
- CC41- a utility logo applied to controlled commodities e.g. footwear, clothing and furniture to acknowledge that the product met the government austerity regulations
- The majority of the population were expected to ‘make do and mend’
- In the UK from the early 1940s wood was in short supply; utility furniture came into existence which was urgently needed due to the heavy losses experienced in cities like London and Coventry where homes were totally destroyed along with furniture and personal possessions
- Newlyweds were allowed to purchase utility furniture to set-up home
- Innovative use of materials to provide furniture, clothing etc – utility still used today to reference items with a practical use where function is given preference over style

END OF MARK SCHEME